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Performance Comparison of Mobility Generator C4R and MOVE using Optimized Link State Routing (OLSR)

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under Vehicular Ad-hoc Networks (VANETs) Environment

Abstract:- Vehicular Ad-hoc Network (VANET) is a specific class of Mobile Ad-hoc Networks (MANET) and asa main backbone for the future technology such as Smart City that facilitate ubiquitous communication. Based on the communication categories, VANETs is divided intovehicle-to-vehicle communication and vehicle-to-infrastructure communication using a wireless network.However, VANET implementation in the real world is still facing difficulty,especially for vehicle-to-vehicle communication. Several research have been done by creatingmobility generator to build a real VANETs environment into a simulation. In this research we studywell-known VANETs' mobility generators such as C4R and MOVE to see how those generators reflect the performance of Optimized Link State Routing (OLSR) under different scenarios.Real map are used to show how OLSR performedunderdifferent level of vehicle density in the simulation. We measure the performance of OLSR based onpacket delivery ratio (PDR), end to end delay (E2D) and routing overhead (RO)The experimental resultshowsthat VANET scenario produced by MOVE has higher PDR and yield a lower and stable E2D while the value of RO is higher. On the other hand C4R produce a lower PDR, higher E2D and lower RO value.

Keywords: -*C4R, MANET, MOVE, NS-2, OLSR, VANET.*

I. INTRODUCTION

The important role of Informatics Communication Technology (ICT) is to improve the quality of human life. In the near future, ICT will become the backbone of Smart City concept which implement one of the recent technology such as Vehicular Ad-hoc Network (VANET) [1] as it shown on Fig.1. It utilizes wireless channel to create an ad-hoc networks among the vehicles. Thus, it does not fully rely on static infrastructure to communicate. However, the challenge is how to create and maintain the stable link communication among the vehicles under highly dynamic environment in VANETs. Another issue that faced by the researchers was the cost needed to develop real VANETs environment in the city is too expensive. Thus, several mobility generators such as C4Rand MOVE [2] have been created to solve those problem.

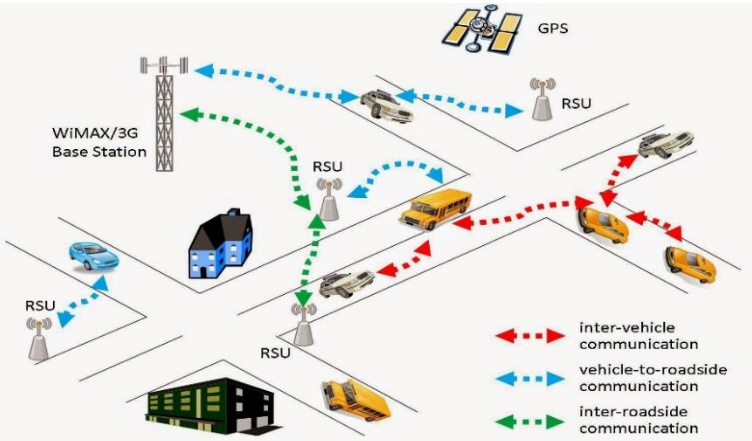

Fig. 1 Communication Topology of VANETs [1]

In order to maintain the reliability of link communication among vehicles, ad-hoc networks topology need to be built by routing protocols. There are so many proposed routing protocols for VANETs [3]. It categorized into proactive and reactive. In this paper we investigate the performance of one of the well-known proactive routing protocols, Optimized Link State Routing (OLSR) [3], under different kind of scenarios generated by C4R and MOVE. We implemented OLSR using NS-2 while the VANETs scenarios are generated by C4R and MOVE. The uniform grid map and real city map are used to compare the performance of OLSR under the variation of network density and vehicle speed. Then we analyze the gap between C4R and MOVE based on the OLSR performance metrics such as packet delivery ratio (PDR), routing overhead (RO)andend to end delay (E2D).

II. RELATED WORKS

2.1. Optimized Link State Routing (OLSR)

OLSR is the famous example of proactive routing protocol [3]. It provides all route to all the node in the networks at all time. OLSR adopts the classical concept of link-state and Dijkstra algorithm to find the shortest path between sourceand destination nodes. OLSR, optimized the number of broadcasted link-state packets by creating Multipoint Relay (MPR). Only of these MPR nodes responsible for rebroadcast the link-state packets to the whole networks. Thus, it effectively can reduce the number of flooded control traffic in the network as it shows in Fig.2.

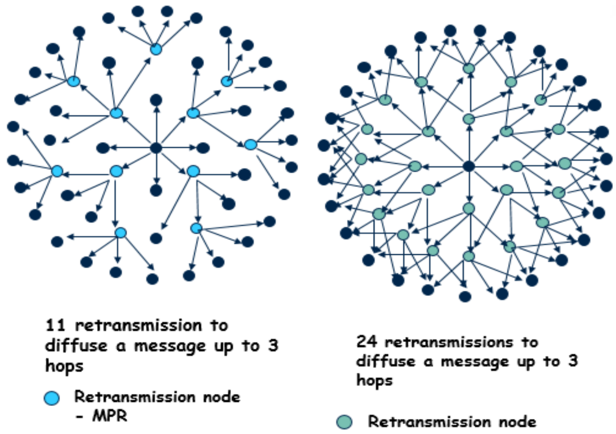

Fig. 2Flooded Link-State Packet by MPR in OLSR [3]

All nodes in OLSR broadcast HELLO message periodically to recognize its neighborhood. In order to select MPR node, all nodes in OLSR should recognize not only their one-hop neighbors, but also two-hop neighbors. The neighbors that have better coverage to the other nodes, will be selected as a MPR. This MPR will be broadcast link-state packet which is called Topology Control (TC) to all of their neighbor until it covers all the networks. Based on the received TC, every node will update its routing table to store the route information to every node in the networks.Thus, based on the maintained routing table information, all nodes in the networks have route information to reach all of the others in the networks.

2.2. VANET Mobility Generator

Developing VANETs mobility in real world will be spent a large amount of money. Thus many researchers in VANETs create realistic mobility generator which is able to reflect and simulate the real VANETs mobility. It is very important to select the most realistic scenario for VANETs mobility model in order to produce reliable result formeasuring the performance of routing protocol. There are so many kind of VANETs mobility generator have been developed such as C4Rand MOVE [2]. C4R (*Citymob 4 Roadmaps*)is a one of mobility generator specifically created for VANETs. C4R provides traffic light simulation and also traffic regulation as in the real city streets. It has two constrains which are handle the flow or the movement of vehicle based on the regulation for each of the road segments such as speed limitation, traffic light and stop sign [6]. On the other hand, *MObility model generator for VEhicular networks* (MOVE) created by*Simulation of Urban Mobility* as known as SUMO. SUMO yields the log file that consist of the vehicle movements' information ordered by time series. This vehicle mobility file will be imported to Network Simulator 2 (NS-2) and added OLSR protocol into the simulation. SUMO considers both micro and macro aspect into the traffic simulation. Thus it produces more realistic vehicles behavior when they move around on the street. Real map is imported by using OpenStreetMap as it shown in Fig.3. It convert the real street map from Google Map into graph that constrained the movement of vehicles in the simulation.

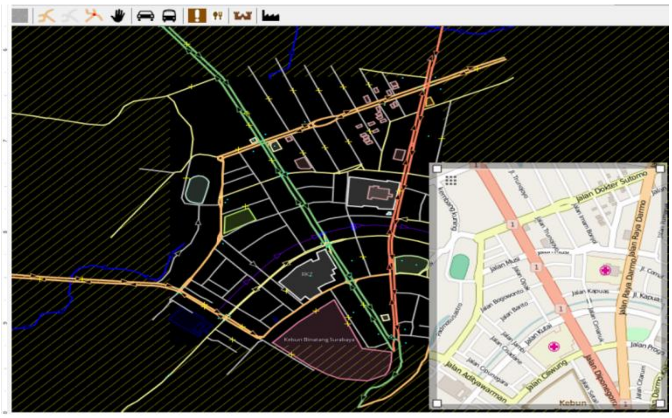

Fig. 3OpenStreetMap for Real Street Map

III. SYSTEM DESIGN AND SCENARIOS

The road-map of our simulation is shown in Fig.4. It combines two kind of simulator, NS-2 and Mobility Generator (C4R and SUMO). NS-2 simulate the Optimized Link State Routing into VANETs scenario which is generated by C4R and SUMO.

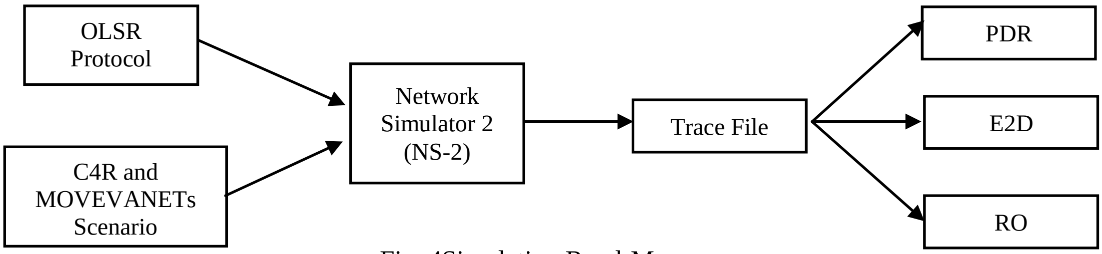

Fig. 4Simulation Road-Map

The performance metrics such as packet delivery ratio, end to end delay and routing overhead of OLSR will be calculated and analyzed. Each of these performance metrics are calculated based on the formula. Packet delivery ratio is calculated by dividing the number of received data packets by the number of sent data packets as it shown in equation (1). The end to end delay is formulated in the equation (2) as the average delivery delay of data packets sent. The delay itself is calculated as the gap between received time and sent time of data packets. The routing overhead is the total number of control packet sent by OLSR during the simulation time. This control packet is represent topology control packets that periodically generated by all the nodes and distributed by MPR nodes through the networks.

$$PDR = \frac{received}{sent} \times 100\% \quad (1) \qquad E2D = \frac{\sum_{i \le sent}^{i=0} t_{received\ [i]} - t_{sent\ [i]}}{sent} \quad (2)$$

The complete simulation parameter [7] that used in this paper is shown in Table 1. We setup the simulation duration for 200 seconds and run it 30 times for each scenario. Every vehicle is randomly placed on the map and moves into a pre-determined destination coordinate. We vary the number of vehicles on the map from 25 to 100, in order to simulate the density level of city traffic. User datagram protocol is implemented for 802.11 wireless communication model.

Table1. Simulation Parameter

No.	Parameter	Specification
1	Network simulator	NS-2, version 2.35
2	Routing protocol	OLSR
3	Simulation time	200 second
4	Data packet traffic start	- C4R = 100 – 200second - MOVE = 100 – 200 second
5	Map size	1500 m x 1500 m
6	Number of vehicles	25, 50, 75, 100
7	Transmission range of vehicle	350 m
8	Connection type	UDP

9	Traffic type	Constant Bit Rate (CBR)
10	Number of connection	1
11	Data packet interval	1 packet / second
12	Packet size	64 bytes / 512 bit per second
13	MAC protocol	IEEE 802.11
14	Propagation mode	Two-ray ground propagation model
15	Antenna type	OmniAntenna
16	Interface queue type	Droptail/PriQueue

IV. EVALUATION

4.1. Packet Delivery Ratio (PDR) Evaluation

Fig. 5 shows the performance of OLSR protocol under different number of vehicles. At 25 vehicles, OLSR significantly increases its PDR follows the addition of vehicles on the road. However it start to slightly decreasefrom 50 to 100 vehicles. Both C4R and MOVE perform a similar trend at 50 to 100 vehicles. MOVE produces up to 15 % higher PDR than C4R. This is proofed that MOVE able to implement more realistic traffic light module than C4R. It restricted the vehicle for reaching its maximum speed. Thus the variation of vehicle number, affect the performance of OLSR under MOVE scenario. On the other hand, C4R unable to perform realistic traffic light module. Thus, vehicle is easily reaches its maximum speed. This cause the frequent disconnected communication link among vehicles. Moreover the topology of ad-hoc networks is highly dynamic and the number of dropped data packet is increasing. However, due to the lack of realistic traffic light, cause OLSR with C4R scenario, produce a constant performanceunder any different level of vehicles density.

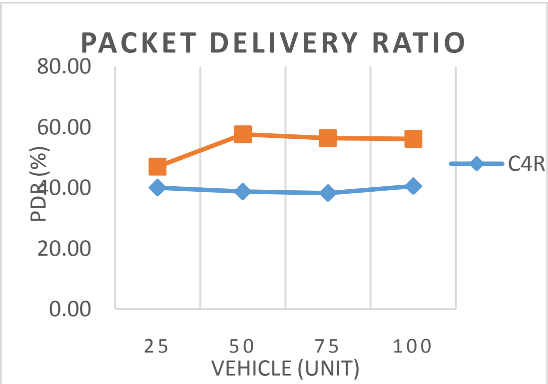

Fig. 5Performance Evaluation on*Packet Delivery Ratio*

4.2. End to End Delay (E2D)Evaluation

Fig. 6 shows the trend of E2D of Optimized Link State Routing protocol under C4R and MOVE scenarios. Under 50 vehicles, C4R grows significantly from 0.02 to 0.12 seconds. It shows that the effect of vehicle mobility created by C4R cause highly dynamic changed of network topology. Due to this frequent change of network topology, several packets have towait for retransmission until OLSR calculate the fresh route to reach the destination. Meanwhile, MOVE shows a more acceptable E2D trend than C4R. It grows up to 0.05 seconds between 25 to 50 vehicles before it reach a constant E2D up to 75 vehicles. However, it shows that its E2D gradually increases based on the vehicle density level.

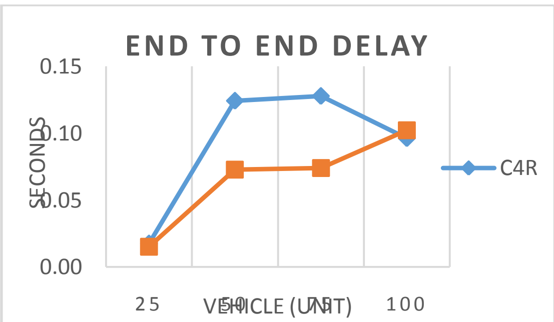

Fig. 6 Performance Evaluation on *End to End Delay*

4.3. Routing Overhead (RO) Evaluation

The routing overhead result showed in Fig. 7. It obvious that OLSR as a proactive routing protocol always generate constant routing overhead. Thus, the addition of vehicle number, will also increase the number of generated control packet. The slightly gap between C4R and MOVE is created due to the different mobility behavior on simulate the traffic light module of VANETs environment.

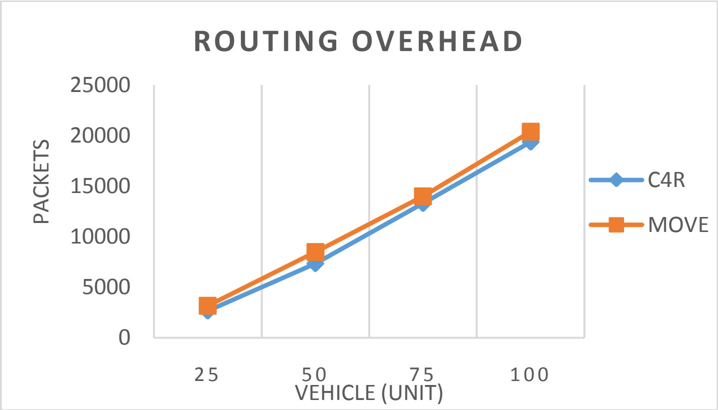

Fig. 7 Performance Evaluation on *Routing Overhead*

Based on those three evaluation on PDR, E2D and RO of Optimized Link State Routing protocol, either C4R or MOVE produce different trend and result. For PDR and E2D, the most significant factor that affected those value is the number of dropped packet. Due to the different way of how C4R and MOVE interpreted the traffic light module, also affect the number of dropped packet. However for RO, it totally depends on the number of vehicles. The more vehicle added into the simulation, the more control packet generated by OLSR as a proactive routing protocol. Thus, mobility factor does not put any effect in the RO for proactive protocol such as OLSR.

V. CONCLUSION

Based on the evaluation, it conclude that VANETs scenario created by MOVE produce a better PDR and E2D than C4R. Since MOVE is able to simulate more realistic traffic light module than C4R, the movement of vehicles is constrained. On the other hand, C4R traffic light simulation still lack of realistic feel. Thus, vehicle has too much high degree of freedom. The most important factor that affect the PDR and E2D is the number of dropped packet. Since C4R gives freedom for vehicle to move, it causes the communication link among vehicle is easily to be broken. So, the number of dropped packet is relatively higher than MOVE. Random positioning of vehicle and also random movement of vehicle also affect the final result of the evaluation. Thus, we run 30 times for each scenario to see the average result and produce a smooth trend.

VI. ACKNOWLEDGEMENTS

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